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Effect of Exposure Conditions on the Long-Term Dielectric Properties of Mortar Samples Containing ASR Gel

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Alkali-silica reaction (ASR) may lead due damage in concrete structures due to chemical reaction between alkalis present in portland cement and amorphous or otherwise disordered siliceous minerals in particular aggregates [1]. Through this reaction, reactive silica binds with hydroxyl and alkali ions and forms a gel, known as ASR gel. Recently, microwave materials characterization techniques have shown great potential for detecting ASR in mortar. However, the comprehensive understanding of variables that affect the extent of ASR in mortar and their interaction with microwave signals, in particular the effect of exposure conditions, requires more investigations. Therefore, parameters related to exposure conditions must be considered when using microwave techniques for ASR detection and evaluation. In this paper, the effect of exposure conditions on ASR gel formation and microwave dielectric properties of mortar samples is investigated. To this end, extended measurements of the complex dielectric constants of three different sets of mortar samples are presented at S-band (2.6 – 3.95 GHz). The samples were cast with ASR-reactive aggregates, and exposed to different conditions. The results shows slightly different permittivities for the differently exposed samples, potentially indicating different amount of ASR gel. This observation was corroborated through UV fluorescence microscopy, where different amounts of ASR gel were observed in the samples. Moreover, the results indicate that ASR gel evolution may be better tracked through loss factor measurements, while pre-existing-gel may be better detected through permittivity measurements.

Acknowledgement:

This work was supported by the National Science Foundation (NSF), as a Collaborative Grant between Missouri University of Science and Technology and Georgia Institute of Technology, under Award No. 1234151. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the NSF.

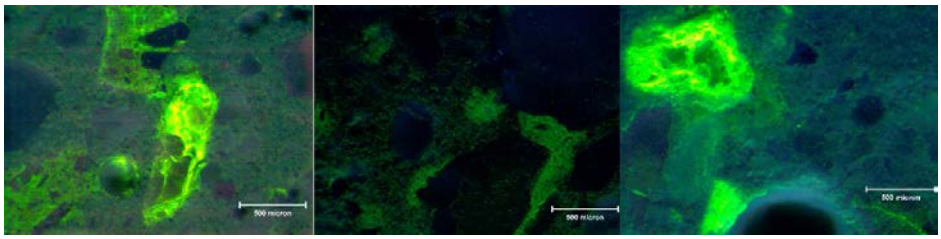

Figure 1. UV fluorescence microscopy images of mortar samples exposed to different conditions.

References:

1. “ACI Concrete Terminology, ACI Standard CT-13,” Jan. 2013.
2. ASTM C856-14, “Standard practice for petrographic examination of hardened concrete,” *ASTM Int., 2014.*